


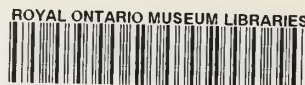
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The Lower Carboniferous Brachiopod Genus *Fusella* M'Coy 1844

by J. B. Waterhouse¹



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The genus *Fusella* M'Coy 1844 is founded on *Spirifera fusiformis* Phillips 1836, proposed for a single small transverse spiriferid from the Carboniferous Limestone at Boland, Yorkshire (fig. 1A-F). The type remains to this day the sole specimen referred to the species. It has been figured only in the form of inadequate sketches, usually repeated from the original figures of Phillips, and is so difficult to interpret that one recent worker, Maxwell (1954, p. 34; 1961), accepted an ancient misstatement by Davidson (1862) that the type specimen is non-costate. Any name proposed so early in the course of palaeontological exploration stands as a threat to later better established names, and *Fusella* has already been used to place *Unispirifer* Campbell (1957) into subjective synonymy. The purpose of this paper is to show that *Fusella* and *Unispirifer* are not likely to be congeneric, judged from a brief examination of the Gilbertson and Davidson collections at the British Museum (Natural History), London, during May, 1967. In the absence of large collections of comparative material, it has not been possible to resolve vital questions of the internal details or shell punctuation of *Fusella*, but suggestions are made which can be tested by workers more conveniently located to complete the work. There is no reason why *Fusella* should not become a reasonably

well-known genus. It is certainly premature to reject the name, as recently proposed by Vandercammen and Plodowski (1967).

Genus *Fusella* M'Coy 1844

Type species—*Spirifera fusiformis* Phillips 1836.

Diagnosis—Transverse from early ontogeny, with alate cardinal extremities, high ventral interarea, slightly incurved ventral umbo and arched valves. Sulcus shallow, with several faint costae, no median costa, elevated margins posteriorly. Fold also elevated posteriorly, at level of rest of shell anteriorly, deeply and widely sulcate, with possibly a few costae. About 11 costae over lateral shell, not branching, crossed by growth rugae and lamellae. Shell possibly punctate. Internal details still not known. Apparent close allies *Spirifer distans* Sow. and *S. bicarinatus* M'Coy have dental and adminicular plates, without syrinx.

Discussion—In proposing the genus, M'Coy (1844) described it as follows:

"Transversely elongate; width nearly four times the length; sides rapidly tapering, conical; mesial hollow wide, smooth; mesial ridge with three ribs; eight round, smooth ribs on each side the mesial fold; it has a wide and greatly hollowed cardinal area, the beaks are much incurved and approximate; the sides diminish rapidly in size from the mesial fold, and are almost perfectly round.

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Length four lines, width one inch three lines, depth four lines.

"This little species might be regarded as the type of a subgenus, (*Fusella*, M'Coy) which might be thus characterised.

"Gen. Ch.—Shell elongate transversely, fusiform; cardinal area wide, much curved; beaks incurved.

"This group would embrace these little Spirifers of the mountain limestone, which have a perfectly fusiform outline, the depth being equal to the length, and the sides cylindrical: the cardinal area is extremely wide in proportion to their size, and is always hollowed, or much curved, thus contrasting with the narrow, flat area of the typical Spirifers, while the strongly incurved beaks distinguish them from the *Cyrtiae*. It would include the *S. bicarinata*, *S. rhomboidea*, &c. &c." (1844, p. 131).

De Koninck (1842, p. 247, pl. 17, fig. 2) had earlier considered *S. fusiformis* to be synonymous with *S. rhomboidea* Phillips and *S. convoluta* Phillips, but later (1887, p. 127) seemed to have abandoned that concept, and referred to *S. convoluta* two Permian species, *S. avicula* and *S. vesperilio* from Australia. Davidson (1862) discussed *Spirifera fusiformis* without mentioning M'Coy's subgenus *Fusella*, describing the shell as "smooth and not ribbed" (p. 36), and in the main description as "finely striate?" and "not ... strongly ribbed" (p. 57). One might read into the latter phrase that the shell could be weakly ribbed, as it is not strongly ribbed, and this is indeed correct. Subsequently many authors referred *Fusella* to the synonymy of *Spirifer*, including Dall (1877), Oehlert (1887), Schuchert (1894, p. 105; 1913) and Paeckelmann (1931, p. 37), whereas Frederiks (1926, p. 405) considered the genus together with *Eospirifer* Schuchert.

Buckman (1908) discussed the genus with other impunctate spiriferids ranging from *Spirifer* to *Brachythyris* and *Reticularia*, referring to it the following species: *S. trigonalis*, *S. grandicostata*, *S. oruithorhyncha*, *S. triangularis*, *S. rhomboidea*, *S. subconvoluta*, and *S. convoluta* from the British Lower Carboniferous, *S. vesperilio* and *S. avicula* from the Australian Permian, and *S. strangwaysi* de Verneuil from the

Russian Upper Carboniferous. He characterised the genus as being wide, with an extended hingeline, ribs coarse laterally, tending to be deficient medianly, and noted that the type "is in the smooth stage when nearly all the ribs have been lost" (1908, p. 29). Several of the species named above are very transverse, with cancellate or feebly pustulose ornament as in the Spiriferidae and Lieharewiinae. Chao (1929, p. 59) and Hamada (1960, p. 355) cautiously followed this view, referring *S. convoluta* and other species to *Fusella*.

Maxwell (1954, p. 35; 1961, p. 89) in erecting *Prospira* which he evidently considered might be closely related, wrongly asserted that *Fusella* is non-eostate and finely striate. He did not state clearly whether he had inspected the type specimen, or accepted Davidson's description, or re-interpreted the illustrations. Although the 1954 text implies that he had seen the specimen, the 1961 text emphatically quotes Davidson in opposing the interpretation offered by Buckman and M'Coy. In his view, the Japanese species, *Fusella nipponigoualis* Minato (1951), is more closely related to *Prospira* than to *Fusella*.

A new concept of the genus was proposed by Beznosova (1959) and Ivanova (1960, p. 268). They included *S. tornacensis* de Koninck and similar transverse spiriferids with extremities alate at an advanced stage of ontogeny, shallow sulcus and very low dorsal fold, and low rarely bifurcating costae (some over the sulcus and fold), and fine cancellate lirae. *S. tornacensis* probably belongs to *Unispirifer* Campbell (1957), based on *S. striatconvoluta* Benson and Dun (1920) from the Tournaisian of east Australia, and Beznosova and Ivanova therefore tentatively placed *Unispirifer* in the synonymy of *Fusella*. Though the Russians had not examined the types, the figures and descriptions of *Fusella fusiformis* indeed suggest a close relationship. Campbell, by making no mention of the affinities or dissimilarities between the two forms, failed to guard against such a possibility.

Pitrat recognised the validity of both genera and repeated the old unsatisfactory sketches of *Fusella*. He commented (1965, p. 705) that "Other species commonly

placed in *Fusella* seem assignable to *Unispirifer*," with the implication that the two are likely to be congeneric, but that final proof is lacking because of the poor preservation of the type of *F. fusiformis*. A similar stand was taken by Vandercammen and Plodowski (1967), who proposed to synonymise *Unispirifer*, *Prospira* and *Grandispirifer* with *Spirifer* but agreed that not enough is known about *Fusella* to pronounce on its position. Carter (1968, p. 1150) used *Unispirifer*, but noted that his species "could have been assigned with some justification to *Fusella* M'Coy 1844, or *Prospira* Maxwell 1954 ... (of which) ... the type species are poorly described and illustrated."

Waterhouse (1966) followed the Russian viewpoint, to regard the two as congeneric, and Grechishnicova (1966) referred to *Fusella* a number of species congeneric with *S. tornacensis* and *Unispirifer striatoconvolutus*.

Possible affinities—From comparison of the type specimen with associated species amongst the Davidson and Gilbertson collections at the British Museum (Natural History), it appears unlikely that *Unispirifer* and *Fusella* are congeneric. Thus, *Unispirifer* may remain in use, assuming that *Imbrexia* Nalivkin 1937, based on *Spirifer imbrex*, is not congeneric and really lacks radial lirae, as Beznosova (1959), Armstrong (1962), and Vandercammen and Plodowski (1967) have recently stressed. *Fusella* itself remains a mystery. It appears to differ from forms such as *Spirifer convolutus* and *S. rhomboides* Phillips, associated with it by Buckman (1908), and to come closest to *S. distans* Sowerby and *S. bicarinatus* M'Coy. Both these species are poorly known; North (1920) ruled out any affinity with *Syringothyris* Winchell, although some evidence supports such a relationship.

Fusella fusiformis (Phillips 1836)

Figs. 1 A-F

- 1836 *Spirifera fusiformis* Phillips, p. 217, pl. 9, figs. 10, 11.
 1844 *Spirifera (Fusella) fusiformis* M'Coy, p. 131.
 1849 *Spirifera fusiformis* Brown, pl. 51, figs. 4, 5.

- 1862 *Spirifer fusiformis* Davidson, p. 220, pl. 13, figs. 15 a, a (two are lettered a).
 1862 *Spirifera (Fusella) fusiformis* M'Coy, p. 131.
 1908 *Fusella fusiformis* Buckman, p. 29.
 1960 *Fusella fusiformis* Ivanova, p. 269.
 1965 *Fusella fusiformis* Pitrat, p. 705, text-fig. 573, 2a, b.

Holotype—Sole specimen figured and described by Phillips (1836). Kept in Gilbertson Collection, British Museum (Natural History).

Dimensions:

Width	Length	Height	Sinal angle
+26.6 mm	8.3 mm	8.1 mm	30°

Description—The specimen is small, inflated and very transverse, with a tiny ventral umbo extended 2.5 mm beyond the hinge, and a high vertically striated ventral interarea. The sides of the sulcus are elevated posteriorly and so is the fold, although it does not protrude above the rest of the shell anteriorly. About nine costae lie over the ventral flanks, and the shell is smooth beyond. There seem to be two very faint sulcal costae posteriorly, and four on one side of the sulcus in front. No sign of a median costa is visible, even where the shell enters the matrix posteriorly. Finer radial striae are probably due to the fibrous nature of the shell, which is somewhat decorticated. Dorsal costae are better defined, numbering 11 each side of the fold. The fold contains a deep median slit and faint signs of two or three possible costae each side, with perhaps another pair in front. Growth-lines are well defined on the dorsal valve near the anterior margin, about three occurring per millimetre, and low growth rugae cross both valves anteriorly.

Fine dark spots over the shell (15 per millimetre) suggest the likelihood of punctae.

Comparisons—

A. *Unispirifer*, *Spirifer* (Spiriferidae)
 Compared with *Spirifer striatoconvolutus* Benson and Dun, the type species of *Unispirifer*, *Fusella fusiformis* is more trans-

verse in early ontogeny, with narrow but less tapered extremities, and a higher ventral interarea. In *Unispirifer*, the sides of the ventral sulcus are less elevated posteriorly, and the fold is slightly less prominent posteriorly, not so obviously sulcate, and slightly more elevated anteriorly than in *Fusella*. Costae bifurcate more in *Unispirifer*, and are more conspicuous over both the sulcus and fold.

Some allies come moderately close. The Bolland specimen B 238 *Spirifer semicircularis* Phillips (1836, pl. 9, fig. 15) lacks an elevated dorsal fold; and a specimen identified as *S. attenuatus* (Sowerby) – 74321 from Black Rock, in the Avon section at Bristol, has its low fold defined by grooves.

B. Spirifer rhomboidea, S. convoluta, S. trigonalis

(Fig. 2 G–J; Fig. 3 A, B)

S. rhomboidea Phillips (1836, p. 217, pl. 9, figs. 8, 9; Davidson, 1862, pl. 35, pl. 5, figs. 2, 3) from Bolland, the same locality as *Fusella fusiformis*, has a similar overall shape and high interarea, deep median slit in the dorsal fold, and absence of a median costa. This is one of the species originally assigned to *Fusella* by M'Coy. The costae are stronger, the ventral umbo more prominent, and the dorsal umbo and fold higher than in *F. fusiformis*. Other British Museum specimens such as B 95783-4 from a quarry in Lower Carboniferous west of Castleredmond House, south-east of Middleton, Cork, Ireland, may be allied to *F. fusiformis*, although the dorsal fold is a little more conspicuous and costae a little stronger. Growth lines are comparable.

Davidson (1862, p. 35) synonymised *Spirifera rhomboidea* with *S. convoluta* Phillips (1836, p. 217, pl. 9, fig. 7; refigured by Davidson, 1862, p. 35, pl. 5, fig. 9). The type of *S. convoluta* is transverse with well-defined concentric ornament and strong plicae, of which a few bifurcate anteriorly. Posteriorly two costae arise in the sulcus, followed by one or two anteriorly on the flanks. The ventral interarea is of modest height, and the dorsal fold has a median broad rib with other ribs to each side (fig. 3A). Growth-lines seem a little more rounded than in *Fusella fusiformis*, and the

shell has scattered black specks, dubiously suggestive of punctae. *Spirifer convolutus* is definitely not conspecific with *Fusella fusiformis*, having a different fold, stronger costae and perhaps coarser punctae, although it is similar in overall shape, including transverse profile. Among the specimens figured by Davidson (1862, pl. 5, figs. 12, 13) from the Carboniferous Limestone near Clitheroe, and near Thornley, Preston, B 5207 has a deeply depressed fold and four sulcal costae. Growth-lines on another specimen are rounded in outline in early ontogeny. Four costae are seen on the dorsal fold, with a median groove, but the two middle ones may fuse anteriorly, to give three costae.

A specimen from Thornley Quarry, Chipping, Lancashire (Davidson, 1862, p. 35, 223, pl. 50, fig. 1) is transverse with four costae on the fold, and faint sulcal costae, high interarea and growth rugae (fig. 3B).

The British Museum specimen B 5266 figured as *Spirifera triangularis* Martin from the Carboniferous Limestone at Settle, Yorkshire by Davidson (1862, pl. 50, figs. 12–14) is very alate with a median costa in the sulcus, high ventral interarea, and high fold.

In summary, these shells are moderately similar in shape, but the costae are generally better defined, the dorsal fold higher than in *Fusella fusiformis*, and sulcus often deep with a median costa. The shell is apparently impunctate, and the description of tiny pustules superimposed on a cancellate ornament in the supposedly allied species *Spirifera trigonalis* Martin (fig. 2 G–J) by Davidson (1862, p. 323, pl. 50, fig. 9a) suggests an alliance with the Licharewiinae. Similar ornament was reported by Davidson for the highly alate species which he referred to *Spirifer triangularis* Martin, which comes closer to the *S. convolutus* group in being highly transverse, though having a simpler fold and strong concentric growth lines.

C. Tylothyris

Tylothyris laminosa M'Coy is moderately close in shape and high interarea, but has a higher non-sulcate fold and coarser costae in most specimens. However specimen B 22762 from the Carboniferous Limestone (no

further locality detail known) has unusually fine costae.

D. Syringothyris cuspidata
(Fig. 2 A–F)

The possible presence of punctae in *Fusella fusiformis* suggests that *Fusella* might be allied to *Syringothyris* Winchell and allies. *Fusella* certainly resembles this genus in general transverse outline, high ventral interarea, subdued anterior fold, and simple costae. On the other hand the shell of *Fusella* is more arched, the interarea and ventral umbo are more incurved and the sulcus and fold both costate and better defined than is usual for *Syringothyris*.

Among specimens of *S. cuspidata* (Phillips) examined at the British Museum (Natural History), BB 40831 from the North Bluff of Treak Cliff, Derbyshire has a transverse early outline judging from growth-lines which are very like those of *Fusella* in strength (fig. 2 A–F). Costae are comparable, and punctae not obvious. The dorsal umbo seems more prominent, but is broken, and the dorsal fold is raised posteriorly in specimen BB 40831, with a similar wide sulcus which lacks any trace of costae. Specimen B 52092 figured as typical *Syringothyris cuspidata* by North (1920, pl. 11, fig. 8; pl. 12, figs. 1a, b) from D 2 subzone, Castleton, Derbyshire, has a more rounded outline early in ontogeny, with no sulcus in the fold, and coarser costae.

Bolland specimens labelled B 297 which were figured by Phillips (1836, p. 216, pl. 9, figs. 1, 4) and included in synonymy by North (1920, p. 186) have a much more conical ventral valve with a straight, not incurved ventral umbo, and a narrow dorsal sulcus in one but not the other specimen. Costae are of comparable strength, and growth lines show that the specimens were not quite so transverse as in *Fusella fusiformis*. Another Bolland specimen from the Gilbertson Collection, also registered as B 297, is closer to *F. fusiformis* in having a similarly incurved ventral umbo, with the shell elevated each side of the posterior sulcus, a low fold with raised borders, and a low inner pair of costae separated by a groove. The two are very similar, although in *Syringothyris cuspidata* the fold is higher

and the costae stronger than in *Fusella fusiformis*.

Other specimens figured as *Syringothyris cuspidata*, such as B 7666 from the Carboniferous Sandstone at Kendal (Davidson, 1862, p. 44, pl. 8, fig. 20), or B 21773 from the Carboniferous Limestone of Ireland (King, 1868, pl. 2, fig. 11) have similar fine costae, but are not particularly closely related.

E. "Spirifer" distans, "S." bicarinatus
(Fig. 1 G–L, Fig. 3 C)

The most closely related species among those examined belong to *Spirifer distans* Sowerby and *S. bicarinatus* M'Coy, supposedly restricted to the Carboniferous of Ireland. They have a high interarea, and are more convex than *Syringothyris* species, with a weakly incurved ventral umbo. M'Coy (1862) referred *Spirifer distans* to *Cyrtia* (with *Syringothyris cuspidata*) and regarded *Spirifer bicarinatus* as closely allied to *Fusella fusiformis*.

Specimens assigned to *Spirifer distans* Sowerby from Millicent, Ireland, by Davidson (1862, pl. 8, figs. 5–8) have a sulcate fold, costae over the sulcus, and faint lateral costae, but the ventral valve is higher and less incurved than that of *Fusella fusiformis*. However, growth-lines suggest that the Irish shells were transverse in early ontogeny. The shells seem to be penetrated by punctae coarser than those possibly present in *F. fusiformis*. *Spirifer bicarinatus* M'Coy (1844, p. 129, pl. 22, fig. 10; refigured in Davidson, 1858–63, pl. 8, fig. 18) was regarded by North (1920, p. 192) and Davidson (1880, p. 281) as a variety of Sowerby's form, characterised by a more elongated outline and more acute cardinal extremities. It is distinguished by the sulcate fold, without costae, as noted by de Koninck (1887). Among specimens kept at the British Museum (Natural History) and identified with this form, B 91379 from the Lower Carboniferous Clane Quarry, Kildare, Ireland has a low dorsal fold with sulcus, a somewhat higher ventral umbo and a flatter ventral interarea than in *Fusella fusiformis* (fig. 1 G–L). The shell is apparently finely punctate in that its shell carries tiny pits and dimples, but it has been decorticated, so the ap-

pearance of the surface could be deceptive. The specimen is larger than the type of *F. fusiformis*, and consequently has a higher interarea. There are no apparent costae preserved in the dorsal sulcus, but several faint costae traverse the ventral sulcus. Serial sections (fig. 3 C) show that the dental plates are high and subparallel, diverging towards the hinge at 30°. They converge on high supporting plates termed adminicula (see Browne, 1953; Campbell, 1959; Waterhouse, 1968) which diverge to the floor of the valve at 25°, and anteriorly from each other at 25°. There is no sign of a syrx, but the plates are separated by a medium white sliver representing either a septum or a parting between the two dental plates.

Another Kildare specimen of *Spirifer bicarinatus* registered as B 30308 has finer ribs and highly transverse growth lines, with a sulcus in the fold, and very closely resembles *Fusella fusiformis* in shape.

Subfamilial affinities—The subfamilial position of *Spirifer distans* and *S. bicarinatus* is open to question. Davidson (1867; 1880, p. 281) referred the two to *Syringothyris* because King had stated that the shell is perforate, and de Koninck (1861) had recorded a syrx. North (1920) considered that de Koninck's specimens are not *Spirifer distans* but probably a species of true *Syringothyris*. He emphasized that they differed from *Syringothyris* species in having costae over the sulcus and fold, with up to eight costae in the ventral sulcus and traces of costae over the sulcus in the fold. Moreover, he stated that the lateral slopes are more tumid than in *Syringothyris* species, the ventral umbo is wider, the ventral interarea lower and more incurved without a three-fold division, the delthyrium narrower and the costae bifurcate anteriorly. He could find no punctae, but suggested that the shell is too recrystallized to be sure of their absence. Since punctae do seem to be present, the specimens may be syringothyridid, distinguishable from *Syringothyris* by the criteria enumerated by North. Furthermore, North (1920, p. 192) asserted that delthyrial supporting plates are present, without a syrx. This accords with my

own observation. If correct, and if *Spirifer distans* is punctate, and closely allied to *Fusella fusiformis*, it appears that *Fusella* is a syringothyridin genus, characterised by its transverse outline, ventral interarea of modest height, inflated but not conical ventral valve, costate sulcus and very feebly costate sulcate fold, and dental plates supported by adminicula, without a syrx. Curiously enough such an interpretation would suggest that *Fusella* is close to another genus proposed by Campbell (1957), *Asyrinxia*, based on *Spirifera lata* M'Coy (1847) from the Upper Tournaisian lower Burindi Group of New South Wales. Campbell (1957, p. 81) anticipated this conclusion. He commented on the close approach of *Asyrinxia* to *Spirifer distans*, apart from the absence of bifurcate costae (which are rare in *S. distans* anyway), the absence of a three-fold division of the cardinal interarea (which I have not been able to confirm for *Fusella* because the specimen is obscured by matrix), and the supposed absence of punctation (but North warned that this is not established for *S. distans*). A more obvious difference lies in the nature of the dorsal fold, which is not sulcate or depressed in *Asyrinxia*. This is significant at least to the subgeneric level.

Conclusion—*Fusella* M'Coy is a valid genus, probably related to members of the Syringothyrididae. It does not belong to the Spiriferidae as concluded recently by Beznosova (1959), Ivanova (1960), Waterhouse (1966) and Grchishnicova (1966), and is not a senior synonym of *Unispirifer* Campbell. More work is needed to show the exact nature of the internal plates. Present evidence suggests that there is no syrx.

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out with the assistance of the National Research Council of Canada, grant 319-111-70.

Summary—The type specimen of *Spirifer fusiformis* Phillips, the type species of *Fusella* McCoy, is re-examined and re-figured. Closest affinities appear to lie not with

Unispirifer Campbell as supposed by several recent workers, but with *Spirifer distans* Sowerby and *S. bicarinatus* McCoy. These probably belong to the Syringothyrididae, and probably have dental and adminicular places without a syrinx.

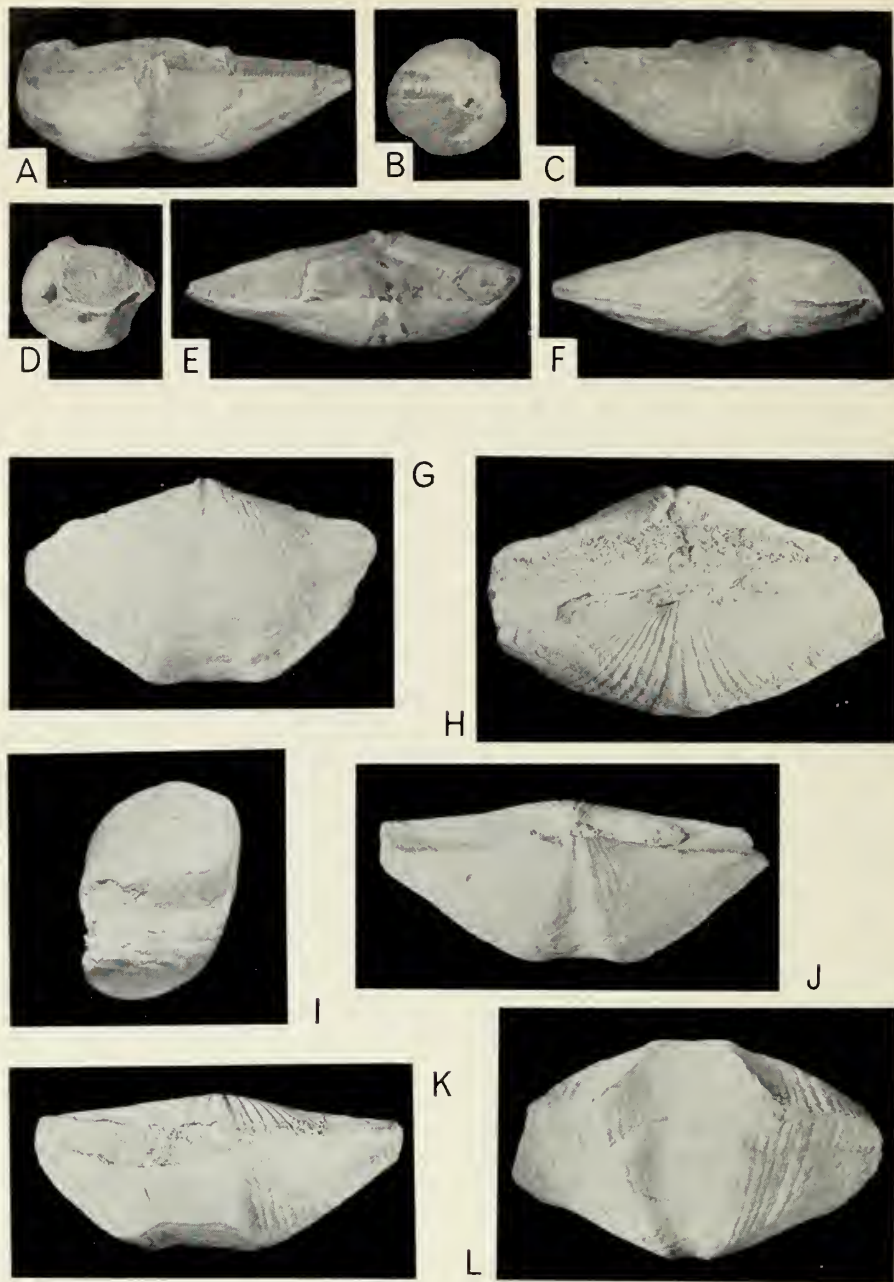


Figure 1

A-F—*Fusella fusiformis* (Phillips), original specimen from Gilbertson Collection, British Museum (Natural History), London, $\times 1$ approx. Photographs supplied by British Museum (Natural History)

A. Ventral view, tilted to show interarea.

B. Lateral aspect, posterior to right, ventral valve uppermost.

C. Dorsal view, showing deeply sulcate fold and faint decorticated costae.

D. Lateral aspect of other end, posterior to right, dorsal valve uppermost.

E. Posterior aspect, ventral valve uppermost.

F. Anterior aspect, dorsal valve uppermost.

G-L—*Spirifer bicarinatus* M'Coy from Clane Quarry, County Kildare, Ireland. B 91379, British Museum (Natural History), $\times 1$ approx. Photo B. O'Donovan

G. Ventral aspect, showing bifurcating costae.

H. Dorsal aspect, showing high interarea and cleft dorsal fold.

I. Lateral aspect, posterior to left, dorsal valve uppermost.

J. Tilted posterior ventral view, dorsal valve above.

K. Anterior tilted view of dorsal valve showing elevation of the fold.

L. Tilted anterior aspect, dorsal valve uppermost, showing faint costation within sulcus.

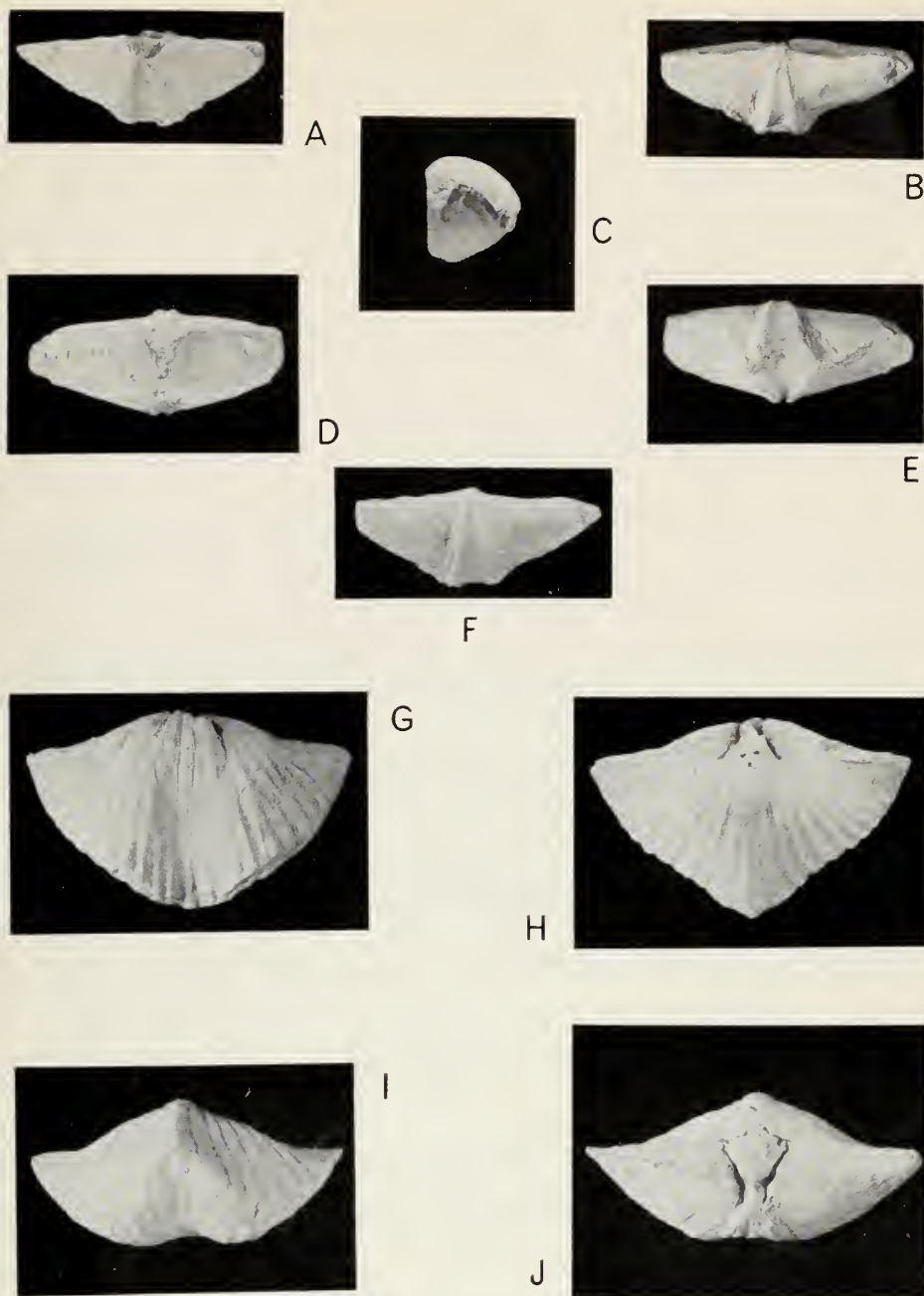


Figure 2

A-F—“*Spirifer cuspidatus* (Phillips),” BB 40831, British Museum (Natural History), from North Bluff, Treak Cliff, Derbyshire, $\times 1$ approx.

A. Ventral valve, broken at umbo, showing faint non-bifurcating costae.

B. Dorsal valve tilted to reveal part of ventral interarea, showing high fold.

C. Lateral aspect, posterior to left, dorsal valve on top.

D. Posterior aspect showing high interarea, dorsal valve on top.

E. Anterior view, dorsal valve on top, showing strong transverse growth lines to right of fold.

F. Dorsal valve.

G-J—*Spirifer trigonalis* Phillips, (Martin), B 244, Gilbertson Collection, British Museum (Natural History), no locality details available, $\times 1$ approx. Ventral, dorsal, anterior and posterior aspects, with dorsal valve on top in I and J. Photo B. O'Donovan

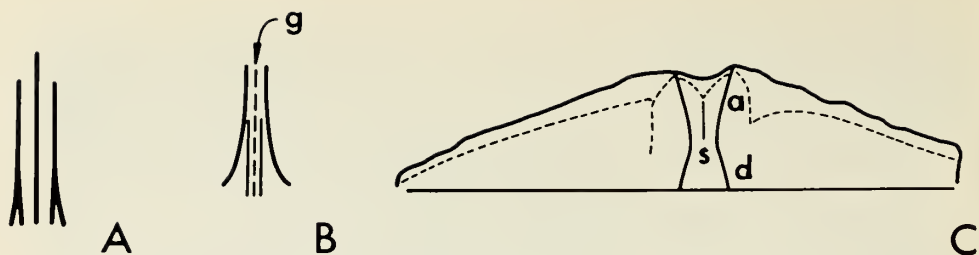


Figure 3

A. B. *Spirifer convoluta* (Phillips). Costation on dorsal fold.

A. Specimen figured by Phillips (1836, pl. 9, fig. 7).

B. Specimen figured by Davidson (1862, pl. 50, fig. 1) from Thornley Quarry, Lancs. Median groove (g).

C. Transverse section of *Spirifer bicarinatus* M'Coy, figured in Fig. 1 G-L. Ventral valve 9 mm from umbo, showing adminicula (a) and dental plates (d) with median line between (s), $\times 2$ approx.

Literature Cited

Armstrong, A. K.

1962 Stratigraphy and paleontology of the Mississippian system in southwestern New Mexico and adjacent southeastern Arizona. *Mem. Inst. Min. Technol. New Mex.*, 8.

Benson, W. N. and W. S. Dun

1920 The geology of the Great Serpentine Belt of New South Wales. *Proc. Linn. Soc. N.S.W.*, vol. 45, pt. ix, sect. B, pp. 337-374.

Beznosova, G. A.

1959 Nizhnkamennougol'nye brakhiopody Kuznestkogo basseina (semeistva Cyrtospiriferidae i Spiriferidae) [Lower Carboniferous brachiopods of the Kuznetz basin: families Cyrtospiriferidae and Spiriferidae]. *Trudy paleont. Inst.*, vol. 75, pp. 1-136.

Browne, I. A.

1953 *Martiniopsis* Waagen from the Salt Range, India. *J. Proc. R. Soc. N.S.W.*, vol. 86, pt. 4, pp. 100-107.

Buckman, S. S.

1908 Brachiopod homeomorphy: '*Spirifer glaber*'. *Q. Jl. Geol. Soc. Lond.*, vol. 64, pp. 27-33.

Campbell, K. S. W.

1957 A Lower Carboniferous brachiopod-coral fauna from New South Wales. *J. Paleont.*, vol. 31, no. 1, pp. 34-98.

1959 The *Martiniopsis*-like spiriferids of the Queensland Permian. *Palaeontology*, vol. 1, pt. 4, pp. 333-350.

Chao, Y. T.

1929 Carboniferous and Permian spiriferids of China. *Palaeont. sin.*, ser. B, vol. II, Fasc. 1, 133 pp.

Carter, J. L.

1968 New genera and species of Early Mississippian brachiopods from the Burlington limestone. *J. Paleont.*, vol. 42, no. 5, pt. 1, pp. 1140-1152.

Dall, W. H.

1887 Index to the names which have been applied to the subdivisions of the class Brachiopoda, excluding the Rudistes, previous to the year 1877. *Bull. U.S. Natn. Mus.*, vol. 8, 88 pp.

Davidson, Thomas

1858–1863 A monograph of the British fossil Brachiopoda. vol. II. Permian and Carboniferous species. London, Printed for the Palaeontographical Society. 51, 280 pp.

Davidson, Thomas

1861 Mémoire sur les genres et les sous-genres des Brachiopodes munis d'appendices spiraux, et sur leurs espèces découvertes dans les couches Carbonifères des Îles Britanniques, traduit et augmenté de quelques notes par Dr. L. G. de Koninck (1859). *Mem. Soc. r. Sci. Liège*, vol. 16, pp. 1–51.

1867 Perforate and imperforate Brachiopoda. *Geol. Mag.*, vol. 4, pp. 311–315.

1874–1882 Supplement to the British Carboniferous Brachiopoda. In his A monograph of the British fossil Brachiopoda, vol. IV. London, Printed for the Palaeontographical Society. pp. 249–315.

Frederiks, G. N.

1926 Tablitsa dlya opredeleniya rodov semeystva Spiriferidae King. [Table for the determination of the genera of the family Spiriferidae King] *Izv. Akad. Nauk SSSR*, ser. 6, vol. 20, pp. 393–423.

Grechishnikova, I. A.

1966 Stratigraphy and brachiopods of the lower Carboniferous of the Rudny Altai. *Trans. Moscow Rept. Nat. Sci.*, vol. 20, pp. 1–184.

Hamada, Takashi

1960 Some permo-Carboniferous fossils from Thailand. *Scient. Pap. Coll. Gen. Educ. Tokyo*, vol. 10, no. 2, pp. 337–361.

Ivanova, E. A.

1960 Otryad Spiriferida [Order Spiriferida] In Orlov, I. A., ed. *Osnovy paleontologii ...* Moscow, *Akademiia Nauk SSSR*, pp. 264–280.

King, William

1868 Monograph of *Spirifer cuspidatus* (*Syringothyris cuspidata* Martin). *Ann. Mag. Nat. Hist.*, ser. 4, no. 2, pp. 1–23.

Koninck, L. G. de

1842–1844 Description des animaux fossiles qui se trouvent dans le terrain carbonifère de la Belgique. Liège, Impr. et lit. de H. Dessain. 650 pp. + atlas of 69 plates.

1887 Faune du calcaire carbonifère de la Belgique. Sixième partie, Brachiopodes. *Ann. Mus. r. d'Hist. Nat. Belg.*, t. 14.

Maxwell, W. G. H.

1954 Upper Paleozoic formations in the Mount Morgan district—faunas. *Pap. Dep. Geol. Univ. Qd.*, vol. 4, no. 5, 54 pp.

1961 Lower Carboniferous brachiopod faunas from Old Cannindah, Queensland. *J. Paleont.*, vol. 35, no. 1, pp. 82–103.

M'Coy, Sir Frederick

1844 A synopsis of the characters of the Carboniferous limestone fossils of Ireland. London, Williams and Norgate. 274 pp. Republished 1862.

1847 On the fossil botany and zoology of the rocks associated with coal in Australia. *Ann. Mag. Nat. Hist.*, ser. 1, no. 20, pp. 145–157, 226–236 and 298–312.

Minato, Masao

1951 On the Lower Carboniferous fossils of the Kitakami massif, northeast Honshu, Japan. *J. Fac. Sci. Hokkaido Univ.*, ser. 4, vol. 7, no. 4, pp. 355–382.

1952 A further note on the Lower Carboniferous fossils of the Kitakami mountainland, northeast Japan. *J. Fac. Sci. Hokkaido Univ.*, ser. 4, vol. 8, no. 2, pp. 136–174.

Nalivkin, D. V.

1937 Brachiopod Verkhnego i Srednego Devon i nizhnego Karbona severovostochnogo Kazakhstana [Brachiopoda of the Upper and Middle Devonian and Lower Carboniferous of northeastern Kazakhstan]. *Trudy tsent. nauchno-issled. geologo-razv. Inst.*, vol. 99, pp. 1–200.

North, F. J.

- 1920 On *Syringothyris* Winchell, and certain carboniferous Brachiopoda referred to *Spiriferina* d'Orbigny. *Q. Jl. geol. Soc. Lond.*, vol. 76, pp. 162–227.

Oehlert, D. P.

- 1887 Brachiopodes. In Fischer, P. H. Manuel de conchyliologie et de paléontologie conchyliologique ... Paris, F. Savy, pt. 11, pp. 1189–1334.

PaECKELmann, Werner

- 1931 Versuch einer zusammenfassenden Systematik der Spiriferidae King. *Neues Jb. Miner. Geol. Palaont. BeilBd.* 67, Abt. B, pp. 1–64.

Phillips, John

- 1835–1836 Illustrations of the geology of Yorkshire. 2d. ed. London, Printed for J. Murray. 2 vol.

Pitrat, C. W.

- 1965 Spiriferidina. In Moore, R. C., ed. Treatise on invertebrate paleontology, pt. H(2): Brachiopoda. Lawrence, Kansas, Geological Society of America and University of Kansas Press. pp. 667–728.

Schuchert, Charles

- 1894 A revised classification of the spire-bearing Brachiopoda. *Am. Geol.*, vol. 13, pp. 102–107.

- 1913 Brachiopoda, revised by Charles Schuchert. In Zittel, K. A. von. Text-book of paleontology, translated and edited by C. R. Eastman. 2nd ed. London, Macmillan. vol. 1, pp. 355–420.

Vandercammen, Antoine and Gerhard Plodowski

- 1967 La question du genre *Spirifer* s. str. et des genres voisins. *Bull. Inst. r. Sci. nat. Belg.*, vol. 43, no. 13, pp. 1–11.

Waterhouse, J. B.

- 1966 Lower Carboniferous and Upper Permian brachiopods from Nepal. *Austr., Geol. Bundesanst. Jahrb., Sonderb.*, no. 12, pp. 5–95.

- 1968 The classification and description of Permian Spiriferida (Brachiopoda) from New Zealand. *Palaeontographica*, Abt. A, vol. 129, pt. 1–3, 89 pp.

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